



GSM BASED ENERGY METER

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In partial fulfillment of the requirement for the degree of
Bachelor of Technology
in the
Department of Electronics and Communication Engineering

Under the Guidance of

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DECLARATION

By the B.Tech Student

I hereby declare that the Report of the U.G. Project Work entitled ***GSM BASED ENERGY METER*** which is being submitted to the **IITE, Indus University**, in partial fulfillment of the requirements for the award of the Degree of **Bachelor of Technology in Electronics and Communication Engineering** in the department of Electronics and Communication Engineering, *is a bonafide report of the work carried out by us*. The material contained in this Report has not been submitted to any University or Institution for the award of any degree.

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Date:

BONAFIED CERTIFICATE

This is to certify that the U.G. project work report entitled **GSM Based Smart Energy Meter** submitted by **Rathod Rutvik J** (IU1741090029) **Barad Dharmendrasinh A**(IU1841091044) as the record of the work carried out by them accepted as the U.G. project work report submission in partial fulfillment of the requirements for the award of degree of **Bachelor of Technology in Electronics and Communication Engineering** in the Department of **Electronics and Communication Engineering of IITE, Indus University** during the academic year 2020-2021.

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ABSTRACT

This proposed project presents a GSM Based Energy Meter for automatic metering and billing system. The integration of a microcontroller and GSM short message service (SMS) provides the meter reading system with automatic functions that are predefined. The GSM module requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Direct current (DC) components are used to control alternating current (AC) loads. To isolate these components from each other, relays with a network of resistors and diodes are used. Users can recharge and control loads remotely. Utility companies also have remote access to the system such as fault diagnosis and communicating with clients. The proposed energy meter system (EMS) transmits data like consumed energy in kWh. Other advantages include that the system provides domestic power consumption accurately, safely and with a relatively fast update rate

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1 Introduction

Electricity is one of the vital requirement for sustainment of contents of life. It should be used very judiciously for its proper utilization. But in our country we have lot of locality where we have surplus supply for the electricity while many areas do not even have access to it. Our policies of its distribution are also partially responsible for this because we are still not able to correctly estimate our exact requirement and still power theft is prevailing. On the other hand consumers are also not satisfied with the services of power companies. Most of the time they have complaints regarding statistical errors in the monthly bills. With this we can monitor meter and track if any fault is there or not. In previous meter a circular metal strip rotates and according to that rotation we calculate the consumption. But our meter works on pulse which is created according to consumption and we previously connected android board which monitor the pulse and according to pulse Unit is Counted. With the help of this project we are aiming to Provide Prepaid service According to energy consumption Unit Will Calculated and Meter will turn On until the Remaining Balance in Consumer Account. In this way we can reduce human efforts needed to record the meter readings which are till now recorded by visiting every home individually

2 Motivation

- All about our research we take care about one problem that is reduce human efforts needed to record the meter readings which are till now recorded by visiting every home individually
- To make a solution we did this low cost project.
- This is our hope to consider this GSM Based Energy Meter.

3 Scope of our Project

- The Braille input device gives the blind person an uncomplicated method to provide the destination address for navigation.
- Communication technologies were easier to invent and consequently were brought to market.
- May this project will spread all around society disable to able. This is a hope, to consider this stick as smart eye for the visual impairments

4 Methodology

Basically this project is divided in parts. Every part of this project is connected to each other. At the items required in this project must place in a Enclosure.

Firstly, Customer have to Recharge the Energy Meter by Registered Mobile Number

Recharge Should Be More then 5 Rs then only System will Work.

Eg; Customer has done Recharge of 1000 Rs then Controller will Automatically Calculate the Units according Recharge Amount has done.

Let Assume Controller has Allocated 200 units to Customer then System Ready Message Will be Send to the customer Registered Mobile Number and Along with Balance and Allocated Units.

After, That Customer has Consumed the 175 Units and 25 units is Left so, Warning message will Send to the Customer that Plss Recharge ASAP Only 25 Units is Left.

And Another Warning Message will be send to Customer when he left only 15 Units.

When all Units has been exhausted then Message will be send that Light is Cutoff Due to Low Balance.

CASE I

When System Failure is Occurs then Emergency Switch is Provided which should be used in emergency Situation. this Switch is will only ON for Fix Timer Period Only(45 Minutes) in this Time Period Electric Company Repair Persons will be Arrived.

CASE II

If System is totally in Working condition No System failure is occurred and Light is Cutoff due to Low Balance and customer will try to turn ON the Emergency Switch for illegal using Purpose then Warning Message will be forwarded to Electric Company and Penalty can be charged from customer.

Working of Circuits and Modules

(a) Working of Energy Meter

It is used for counting Consumed KWh and it will show the units to customer.

(b) Working of GSM module

When microcontroller will send the command to the GSM Module then module is used for sending the SMS to Customer and Electric company. .

(c) Timer Circuit

It will Count the time when Emergency switch is Turn ON and After some timer period it will automatically Turn OFF the Emergency Switch. Timer period can be set by electric company according to Location of customer house.

(d) Working of Optocoupler

Basically it will detect the Pulse from the energy meter and pass to the controller for counting purpose

(e) Working of Relay

It is used for turn off the connection to the load when controller will send command to relay.

5 Hardware Requirement

- Arduino UNO
- GSM Module
- Energy Meter
- Relay
- 555 Timer Circuit
- Optocoupler
- MCB
- LCD Display
- I2C Module

5.1 Arduino Uno

Technical Specifications

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volts
- Input voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)

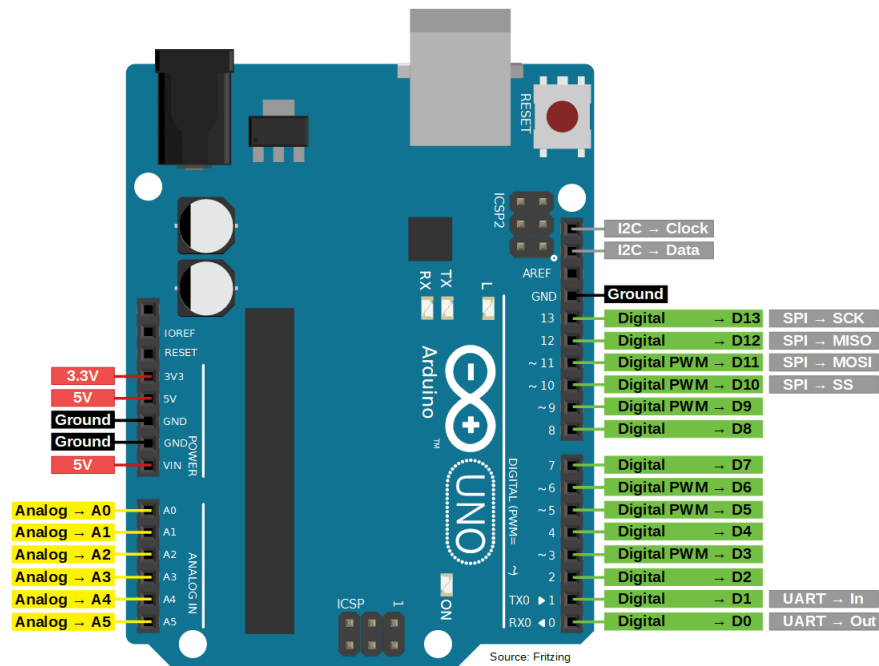


Figure (A): Arduino UNO pinout

- UART: 1
- I2C: 1
- SPI: 1
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- width: 53.4 mm
- Weight: 25 g

Pin description of arduino UNO

General pin functions :

- LED: There is L built-in LED driven by digital pin 13. when the pin is high value, the LED is on, when the pin is Low, it is off.
- VIN: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.
- IOREF: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with toe 5V or 3.3V.
- Reset: Typically used to add a reset button to shields that block the one on the board.

Special pin functions :

- Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, under software control (using pinMode(), digitalWrite(), and digitalRead() functions). They operate at 5 volts.
- each pin can provide or receive 20 mA as the recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50K ohm. A minimum of 40mA must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.
- The Uno has 6 analog inputs, labeled A0 through A5; each provides 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though it is possible to change the upper end of the range using the AREF pin and the analogReference() function.

5.2 GSM Module



Figure 5.2: GSM module

Technical Specification

- Microcontroller: SIM 900A GSM module
- Operating voltage: 4.5V - 12V
- Operating current: ~590mA
- Digital I/O Pins(DIO): 68

Hardware Overview

- GSM modem is a wireless modem that works with GSM networks. A wireless modem behaves like a Hayes compatible dial-up modem. The main difference between a standard Hayes modem and a GSM modem is that a Hayes modem sends and receives data through a fixed telephone line while a GSM modem sends and receives data through radio waves..

GSM Pinout

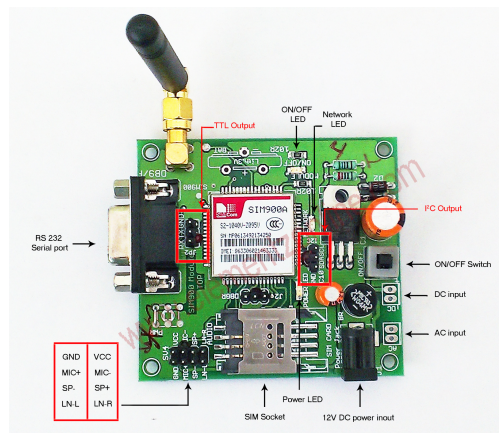


Figure 5.4: GSM pinout

SIM900A GSM Module Pin Configuration Description GPIO

- The GPIO pins help to perform the simple and advance I/O function. All pins give the maximum output equal to the power supply which is useable to control most of the devices like sensors and other modules. All GPIO pins in SIM900A are:
- GPIO1 – Pin40
GPIO2 – Pin41
GPIO3 – Pin42
GPIO4 – Pin43
GPIO5 – Pin44
GPIO6 – Pin47
GPIO7 – Pin48
GPIO8 – Pin49
GPIO9 – Pin50
GPIO10 – Pin51
GPIO11 – Pin67
GPIO12 – Pin68

Status Pins

- The module has two status pins which help to indicate two different kinds of status.
- The first one is the working status of the module and the second for communication status.
- Net status means either the module is connecting to the network or other network functions, etc.

- STATUS – Pin52
NIGHTLIGHT – Pin66

SIM900A Display Interface Pins

- The device offers a 4 pin display interface with itself.
- DISP.DATA – Pin12 – For Display Data
DISP.CLK – Pin11 – For Clock Input
DISP.CS – Pin14 – To enable the display
DISP.D/C – Pin13 – To select between data and command

I2C Pins

- The module has a single I2C protocol pin, which helps to build the application with any module with that communication.
- SCL – Pin38
SDA – Pin37
- SDA for data and SCL for clock pulse.

Keypad interface Pins

- The module will take the keypad data as a 2D matrix value from the KCB pins for each value.
- KBR0 KBR4 (ROWS) – Pin40 Pin44
KBC0 KBC4 (COLUMN) – Pin47 Pin51

Serial Port

- The UART serial interface uses the two pins for proper data communication, which are RX and TX.
- In SIM900A these pins are available but it also has some other pins for status/indication of data.
- RXD – Pin10 – To receive the data
TXD – Pin 9- To send the data
RTS – Pin8 – To send the request of data transmission
CTS – Pin7 – To clear the send request
RI – Pin4 – Ring indicator
DSR – Pin6 – To indicate that data set ready
DCD – Pin5 – To indicate data carry detect
DTR – Pin3 – To indicate data terminal ready

Debug Interface

- Debugging helps the developers to debug the module and update its firmware.

- DBG.TXD:Pin27 – For Data Transmission
- DBG.RXD:Pin28 – For Data receiving

Control Pin

- There is power on pins on the device, which helps to turn it on using external signals.
- There is two power on pins.
- The first one is PWRKEY which requires a LOW signal to power on/off the system.
- To do that, the pins require an input signal for a little bit long time.
- PWRKEY – Pin1
- PWRKEY.OUT – Pin2

Power Pins

- The module SIM900A has multiple types of power pin.
- Some works as input and some as output.
- The most important one to understand is VRTC, which acts as a backup for the internal RTC of the device.
- VBAT(Input): Pin55, Pin56, Pin57
- VRTC (Input/Output): Pin26
- VDD.EXT(OUTPUT):Pin15
- GND: Pin17, Pin18, Pin29, Pin39, Pin45, Pin46, Pin53, Pin54, Pin58, Pin59, Pin61, Pin62, Pin63, Pin64, Pin65

(D) 555 Timer Circuit

Technical Specification

- Operating voltage: 6 - 30V DC
- 1 Channel delay triggered relay module
- Delay time: 0.1 second 999 minutes
- Seven Segment Display



Hardware Overview

- It is 6-30V 1-Channel Delay Power Relay Module with Onboard Adjustable Timing Cycle Switches with Digital LED display. It is mostly used in Home Automation Delay Timer Control Switch Module Timer Controller. The Module operates at Operating voltage range of 6-30V, also it supports micro USB 5.0V power supply. Output capability Can control the device within DC 30V 5A or AC 220V 5A. It can be applied to many fields as there is a wide range of application.

Features

- Wide voltage supply (6-30V) supports micro USB 5V power supply, which is very convenient to use
- The interface is clear and simple, powerful, easy to understand, and almost meets all your needs
- One-button emergency stop function (STOP key), with reverse polarity protection, reverse connection does not burn
- Added sleep mode, enabled, no operation within 5 minutes, automatically turn off the monitor; any key wakes up
- Can set different OP, CL, LOP parameters, these parameters are independent of each other, respectively, saved
- All setting parameters are automatically saved and saved

(D) Optocoupler

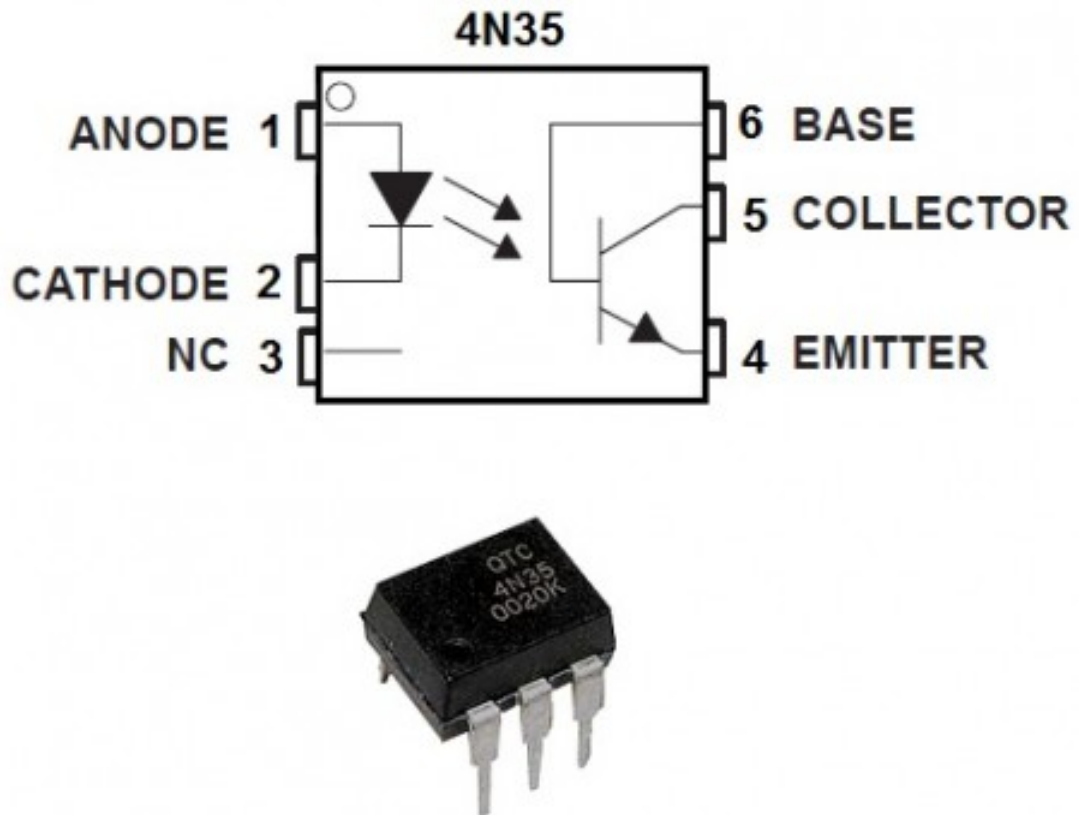


Figure 5.6: Optocoupler 4N35

Technical Specification

- Package Type: 6 Pin Dip SMD
- Transistor Type: NPN Photo Transistor
- Photo Transistor Max Collector Current(IC): 150mA
- Photo Transistor Max Collector-Emitter Voltage (VCEO): 30V
- Photo Transistor Collector-Emitter Saturation Voltage : 0.14 to 0.3
- Photo Transistor Max Emitter-Collector Voltage (VECO): 7V
- Photo Transistor Max Collector Dissipation (Pc): 150 Milliwatt
- LED Max Reverse Voltage (VR): 6V

- LED Max Forward Current: 60 Milliampere
- LED Max Power Dissipation: 120 Milliwatt
- Max Operating Storage Temperature Should Be: -55 to +100 Centigrade for Operating -55 to +150 for Storage.

Hardware overview

- 4N35 is general purpose and widely used optocoupler or we can say it optoisolator photocoupler it is available in 6 pin dip and SMD packages. The device contains two parts one is an IR LED and the other part is the phototransistor. The working of the device is simple when power is applied to the IR LED which activates the LED, the IR light is detected by the phototransistor and as a result the transistor become saturated or switched ON. There are two base of the internal phototransistor from which it can be controlled one is the photo detection or IR light detection and other is connected with the pin6 of the device, therefore it can be controlled by two procedures at the same time.

(E) Energy meter



Figure 5.7: Energy Meter

- An electricity meter, electric meter, electrical me-ter, or energy meter is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device
- Electric utilities use electric meters installed at customers' premises to measure electric energy delivered to their customers for billing purposes.
- They are typically calibrated in billing units, the most common one being the kilowatt hour [kWh]. They are usually read once each billing period..
- When energy savings during certain periods are desired, some meters may measure demand, the maximum use of power in some interval
- Time of day" metering allows electric rates to be changed during a day, to record usage during peak high-cost periods and off peak, lower-cost, periods.
- The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected.

(F) LCD Display

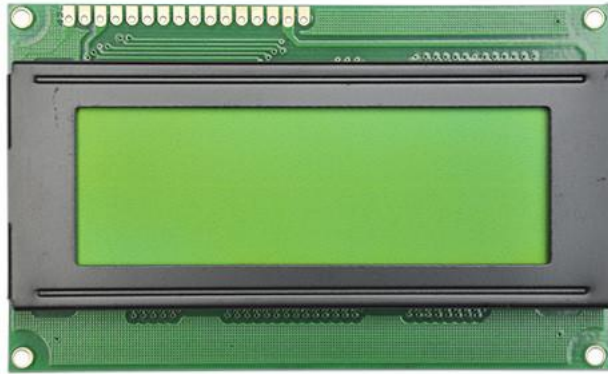


Figure 5.7: LCD Display

Technical Specification

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without back-light
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is build by a 5×8 pixel box Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters
- Available in Green and Blue Back-light

Hardware overview

- LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 20x4 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special even custom characters (unlike in seven segments), animations and so on.

6 Software requirements

- Arduino IDE
- draw.io for block diagrams

6.1 Libraries and Dependence's

- Responsive Analog Read library for stabilizing analog sensor readings
- Software Serial library for serial communication and Arduino board
- EEPROM library for using storage on Arduino board
- Liquid Crystal I2C Library for interfacing 16x2 LCD via I2C module

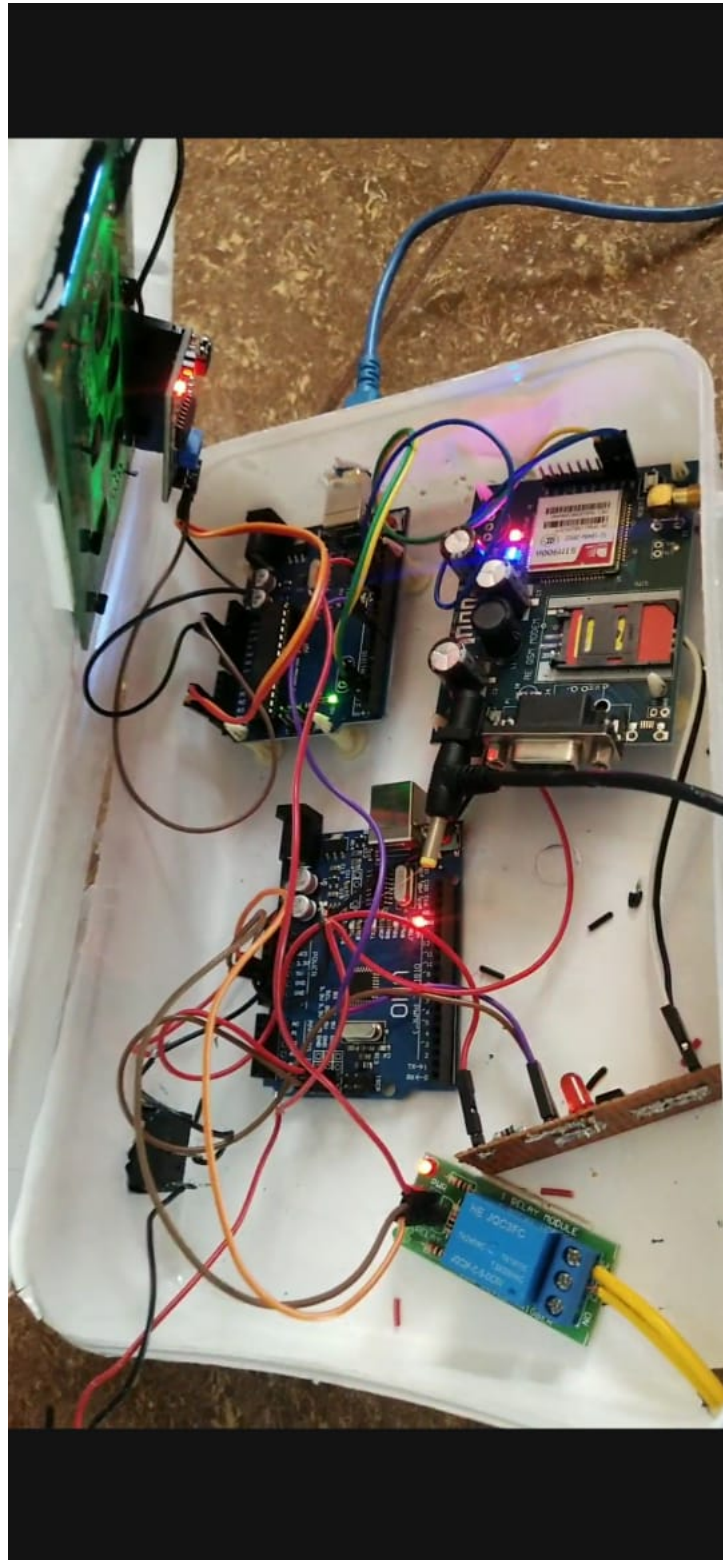
Chapter 7

1 Result

The exerted prepaid electricity meter with GSM module is depicted in the figure. The project asserts a system that will derogate loss of power and overhead due to power thefts and other unauthorized activities. The work system adopts a totally neoteric apprehension of “Prepaid Electricity”. The GSM technology is used so that the user will perceive messages about the consumption of power (in watts) and if it reaches the threshold amount, it will exigently circumspect the consumer to revitalize. This technology can be used in colleges, apartments, domestic houses, MNCs, bank, hospitals etc. The exertion of this project will help in better energy administration, judicious use of energy and also in doing away with the avoidable quarrel over faulty billing. The Prepaid electricity meter system keeps the track of the power usage and will leave little space for reluctant on consumption and billing.



GSM BASED ENERGY METER



Internal Circuit



Figure Display Zero units And Zero Balance

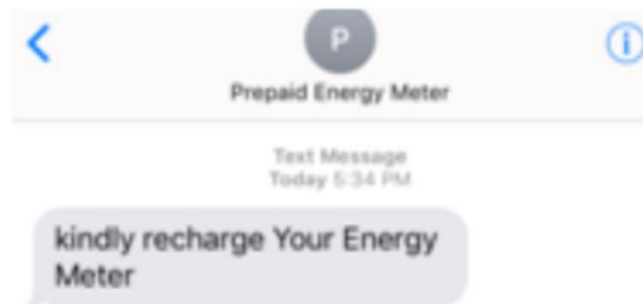


Fig. No balance by sending an SMS through GSM module.

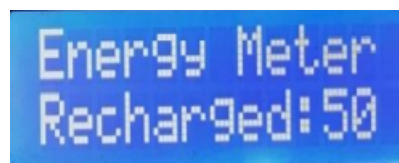


Fig. When customer recharge some amount to the Energy Meter

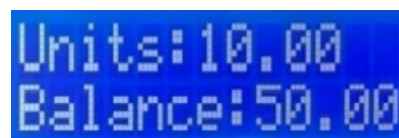


Fig. Show credit

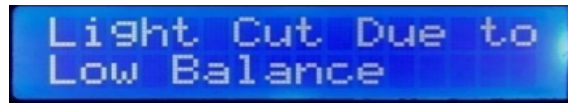


Fig. When energy meter cut off the load due to insufficient balance.

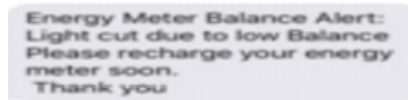


Fig. SMS to inform the customer regarding the status of their connection

9 Future Scope of the project

- The concept of “Prepaid electricity meter” gives the smooth and better flow of capital processing and administration of energy utilities. It can reduce the hurdles which are associated with users living in the areas in which the access of billing and electricity is a problem. It can reduce a large amount of time and manpower for taking and noting down readings. Every consumer using the “Prepaid electricity meter” can recharge to any amount such as Rs 15, Rs 25, Rs 30. As it recharges the account of user all over the Asia so it also reduces the cost of transportation. Adding a mini printer to the “prepaid electricity meter” produces the printed bill

10 Conclusion

- This project is intended to present an overview of prepaid energy meter which can control the usage of electricity on consumer said to avoid wastage of power.
- Prepaid energy meter is a concept to minimise the electricity theft with a cost efficient manner. The users are not bound to pay excesses amount of money, users have to pay according to their requirement. Prepaid energy meter is more reliable and user friendly.
- This prepaid remote energy meter proves to be a boon in the power sector. It control the usage of electricity on consumer said to avoid wastage of power. It helps to the country revenue by stopping current theft and punishing the dishonest customers. However their design has to meet certain prepaid standards and regulations. The only concern is the security and privacy of data as they are prone to cyber attack. However the use of GSM in this particular system provides numerous advantages over methods that have been previously used.
- Data transmission is charged at standard SMS rates, thus the charges are not based on the duration of data transmission. The cost efficient of readings. Developed system also gives information about daily, monthly and yearly power usage. Details regarding daily power consumption will help consumer to manage their power usage. This developed system is reliable and secure as only authorized person can access the system.

11 Bilbliography

- 1 . Sh-Wei Lee, Cheng-Shong Wu, Meng-Shi Chiou, KouTan Wu A research paper on , Design of an Automatic Meter Reading System National Chung Cheng University.
- 2 . M. Popa A research paper on ,Data Collecting from Smart Meters in an Advanced Metering Infrastructure, Politehnica University,Timisoara, Romania.
- 3 . Adnan Rashdi, Rafia Malik, Sanam Rashid, Anam Ajmal, Sulaiman Sadiq, A research paper on, Remote Energy Monitoring, Profiling and Control Through GSM Network, 1 National University of Sciences and Technology, Islamabad, Pakistan.
- 4 . Ali Abdollahi, Marjan Dehghani, and Negar Zamanzadeh, A research paper on, SMS based Reconfigurable Automatic Meter Reading System.
- 5 . A research paper on, Electronic Energy Meter with Instant Billing.
- 6 . Jawed Ahmed, M. Afshar Alam, Abdul Mobin, Shahla Tarannum⁴, A research paper on ,A Soft Computing Approach for Obesity Assessment Computer Science, Jamia Hamdard, New Delhi